vary with the purity and temperature of the water and the electrification of the drops. Experiments should include the salt water of the ocean. As drops falling from a tube or other metal surface depend for their size upon the capillary action between the water and that surface, it would be better to avoid that method of formation of drops and to imitate the rain either by allowing a mass of water to fall through a sieve or by studying the drops formed near the summit of a vertical jet of water at a point where the falling stream breaks into drops. The best memoir upon this subject known to the Editor is one published by J. Wiesner at Vienna in 1895. No copy of this memoir is at hand, but an excellent review is given in the Meteorologische Zeitschrift, July, 1896. In general, Wiesner concludes that the largest drops that fall in tropical rains, and, therefore, anywhere throughout the world, weigh less than 0.26 gram. This result was arrived at by three different methods, but in all three the water was allowed to drop from some solid support, such as the end of a tube or the lower surface of a cloth filter. However large the drops may be at their origin, they soon break up, so that after falling 5 meters their weight does not exceed 0.20 gram, and measurements made during the heaviest natural rains give the maximum rain drop 0.16 gram, while by far the largest number were between 0.06 and 0.08 gram. If drops are ever found larger than these, they can only hold together when falling with velocities much less than would be attained by falling 5 meters. Drops are said to have been observed of one inch in diameter. These must have weighed 7.14 grams and could only have existed for an instant before breaking up. The suggestion that they are simply melted hailstones does not account for their formation, since it would require a considerable time for such large hailstones to melt. They might have been formed by the agglomeration of large drops held up by a momentary rising gust of wind, but could not have held together after that gust had ceased.

Experiments made at Vienna on the velocity of falling drops show that during a fall of 20 meters there is no sensible increase in the velocity, so that drops weighing from 0.01 to 0.25 gram, falling through distances of from 5.5 to 22.2 meters, fall with uniform and approximately the same velocity of somewhat more than 7 meters per second. Special experiments were made to ascertain how far such drops must fall in order to attain this uniform constant speed. The method of determining this distance consisted in examining the characteristics of the blotches made by the falling drops on striking white blotting paper. A maximum velocity is apparently attained by a fall of a few meters, as shown in the second column of the following table, the weight of the drop being given in the first column:

Weight of drop.	Falling distance.	Eventual maximum velocity.
Gram.	*Meters.*	
0.01	1 to 2	7 meters per second in all cases.
0.03	2 to 3	
0.06	2 to 4	
0.07	3 to 5	
0.10	5 to 8	
0.16	8 to 11	
0.20	9 to 14	

It is probable that the acceleration of drops falling from a great altitude does not become zero until the drop has fallen much more than 22 meters. It is also probable that the increasing velocity does not attain a maximum before reaching the earth.

If the latter be true, it seems to the Editor likely that it results from the fact that the drop is perpetually changing its shape, ever adapting itself to the increasing velocity, so that it preserves continuously the shape of a body of swiftest descent for a given velocity and resistance. The resistance is made up of three factors, *viz:* The inertia of the disturbed air and the viscosity, or internal friction, of the air and, also, of the drop. As the drop passes from the cloud to the earth the inertia resistance increases with the steadily increasing density of the air; the viscous resistance to the air increases with the increasing temperature; the viscous resistance to motions within the interior of the drop diminishes with increasing temperature. Finally, the size of the drop diminishes steadily by evaporation, viz, diffusion, even if the speed does not attain such a limit that the internal motions of the drops break it up into fragments.

These several considerations make it probable *a priori* that the drop eventually falls with uniform velocity and this conclusion is confirmed by the observation made by Mach, that the apparent line of descent, when a gentle uniform wind is blowing, is approximately a straight line.

This whole subject lends itself to beautiful laboratory experiments, and the Editor hopes soon to present in the MONTHLY WEATHER REVIEW a very full account of the important experimental methods first invented by Toepler, but perfected by E. Mach and his students at Vienna, for the study of the flow of air around any obstacle, a method that is peculiarly adapted to the study of falling drops. The hydrodynamic formula deduced by Stokes for the viscous resistance to falling spheres does not apply rigorously to the shapes assumed by these liquid drops.

ATMOSPHERIC ELECTRICITY—BRILLOUIN'S THEORY.

The progress of meteorology—like that of all the other sciences—depends much less upon chance discoveries or hasty suggestions than it does upon the wisdom and sagacity of its devotees. The progress of the past two centuries has been marked by the overthrow or complete remodeling of many so-called theories which now seem to us crude, but which in their day represented the best that was known. An immense body of truth is contained in the hundred thousand volumes of experimentation, observation, and mathematics that are preserved in the great scientific libraries, and no one can at the present day afford to disregard the work of his predecessors, or even provisionally give credence to any theory that flies in the face of the facts and principles that constitute modern science. We are all engaged in the study of Nature and shall not make any advance therein, except as we confine ourselves closely to the laws that are manifested in the material creation around us. Owing to the slow progress of our knowledge of electricity we have, until within the past ten years, been completely in the dark as to the origin of atmospheric electricity, earth currents, terrestrial magnetism, and cognate phenomena. Indeed, it is not at all evident that even now we have got at anything very satisfactory. We have, therefore, not encouraged many publications upon this subject in the MONTHLY WEATHER REVIEW. A few years ago Hallwachs showed that the radiation from the sun facilitated electric discharges or neutralized the electrified state of the air, and upon this Arrhenius formulated the theory that the illumination of the air by the sunshine lay at the base of all our phenomena of atmospheric electricity. Since the discoveries of Hertz, Lenart, and Röntgen, the subject has been rapidly developed and Arrhenius' idea has now been further elaborated by Brillouin; although in many respects the theory developed by him in the article that we have reprinted in the current number of the MONTHLY WEATHER REVIEW seems unsatisfactory, yet it has enough of truth and reason to justify calling to it the attention of the students of physics in the United States. Meanwhile, however, the subject of atmospheric electricity is one that demands elaborate observation of facts before we proceed to hypotheses as to its ultimate cause. An admirable summary of our knowledge of the subject, prepared by Elster and Geitel, will be found in Part II of the Report of the International Meteorological Congress at Chicago, 1893.

HURRICANES IN THE WEST INDIES.

From Jos. Ridgway, Jr., St. Thomas, W. I., the Weather Bureau has received the following note, dated October 29:

> Thirty years ago we experienced here, on this date, the most severe hurricane ever known in these latitudes. Apparently there is now no further fear of hurricanes for the season 1897, but I may mention as a peculiar feature that on different occasions since the 15th instant the barometer has been lower than at any time during the period 15th July to 15th October.

ALTITUDES OF CLOUDS.

The well-known voluntary observer, Mr. Barry C. Hawkins, of Horse Cove station, near Highlands, Macon Co., N. C., requests information with regard to the best methods of determining the altitudes of clouds, applicable to the case where the observer is on a mountain or plateau so high that he is sometimes within the cloud. Under date of November 7 he writes:

> In mountain regions the altitudes of clouds are not nearly as great as near the sea level, the relation of the observer to the clouds being entirely changed. For instance, the altitude of a cloud near sea level might be 3,000 feet, the same kind of cloud when passing over a mountain range or plateau 3,000 feet high would touch the earth. Such is the actual case in the Blue Ridge Mountains. In storms the clouds frequently sweep the ground, and at other times the height varies from 0 to 500, 800, or 1,000 feet. When touching the earth the cloud appears like fog and might be called fog, but really the case is entirely different, for the origin is like that of all clouds, and the velocity is often great, being equal to that of the surface winds. When the cloud is dense one can only see a few rods. How can we draw a sharp distinction between such clouds and fogs? It is to be noted that cirrus, cirro-stratus, and rarely cumulus are so low in altitude. The clouds of thunderstorms, which are well developed and not connected with any general storm, rarely touch the mountain, peaks of 4,500 feet or more being free from them. But after thunderstorms small clouds, sometimes not more than 10 feet in diameter, will form perhaps only a few feet above the surface and float in various directions with various velocities, but as the atmosphere clears they disappear. I have sometimes used the following method for obtaining the height of general cloud sheets. Suppose an observer is at an altitude of 2,000 feet and sees a cloud sheet touch the summit of a mountain known to be 3,000 feet high. The altitude of the cloud above will equal 3,000—2,000 = 1,000 feet. Ought such altitudes to be counted as above the observer or as above the sea level?

The altitudes of clouds, as published in connection with the international charts of cloud types are given as above sea level, and this is always to be understood when speaking of clouds unless specifically stated to the contrary. Measurements of clouds are made from elevated points, and in publishing such results, both the measured and the sea level altitudes should be given.

The methods of observation and measurement are so varied that students of the subject should refer to the chapters on this subject in the Editor's Meteorological Apparatus and Methods, Washington, 1887, as also to the articles in the MONTHLY WEATHER REVIEW for April, 1897. The method described by Mr. Hawkins is perfectly proper, and in fact is the one first used by meteorologists in the beginning of the study of this subject; it is quite accurate when there are many clouds whose lower sides are all on the same level, so that an observer by ascending or descending a mountain slope may determine to within a very few yards whether he is on the right level or not. Of course, the actual result depends equally upon the accuracy with which one knows the elevations of his position on the mountain side. This latter consideration is perhaps the most important one when an observer looks upward from below and tries to ascertain at what level the base of the cloud intersects the mountain side. The low clouds that sometimes hang over the city of Washington often hide the summit of the Washington Monument, 550 feet above the ground or 600 feet above sea level, but owing to the absence of a sufficient number of well-defined marks on the side of the Monument, as well as to the haziness of the cloud, it is rarely possible to determine the altitude of the base of the cloud to within 50 feet. In the case of observers on the broad plains of the Mississippi watershed it is important that they give the heights of clouds above sea level as well as above ground, since, in general, the types and motions of the clouds depend equally upon the pressure, the temperature, and the moisture of the atmosphere.

ORIGIN OF THE DESCENDING GUSTS OF WIND.

In the MONTHLY WEATHER REVIEW for August, page 351, the Editor has ventured a few words in connection with an extract from a letter of Mr. Charles A. Love, of Aurora, Ill., who now writes that perhaps the wording of his letter has been misunderstood by the Editor, and that he himself had no idea of suggesting that hail causes the wind, but, on the contrary, that cold, dry wind causes the hail. He intended mainly to raise the question as to—

> Whether it is possible for a stratum of cold, dry air to get between an upper and lower rain cloud and freeze the rain which is falling from the upper cloud. Is it possible for a stratum of cold air, of relatively greater density, to overlap the warmer air at the surface and cause a downrush and at the same time freeze rain into hail, if there should be any rain in the path of the descending cold air? It is often said that a hailstorm in a certain locality is the cause of the cold, although the hailstorm is of limited area and the change to cold weather covers a wide area. The cold air causes the hail and not the hail the cold air.

The Editor owes Mr. Love an apology for reading too much meteorology into his former letter. The fact is, as we understand it, that when a great mass of cool, dry, and, therefore, denser air rolls southeastward over the continent, displacing warmer, moister air, the process does produce thundershowers and hailstorms, and still oftener raw, cold gusts without much rain or hail. It is, therefore, not proper to say that hailstorms or thunderstorms produced this spell of cool weather, since it was the cold air that caused them, and to this extent our correspondent is quite correct.

Denser air can not lie quietly above lighter air near the earth's surface for any length of time, but if the former is in rapid motion, as is oftentimes the case, bounding along over the earth's surface like the ricochet of a cannon ball, it must necessarily descend in gusts here and there precisely as observed by Mr. Love. At other times the word *ricochet* does not correctly express the movement, since sometimes the cold wind blows against an obstacle or blows from hilltop to hilltop over a valley before it has time to descend. The descent is usually slow as compared with the horizontal movement.

But there is another equally frequent case in which it is not the cold air that forms the hail, but the hail and rain that forms the cold gust. This latter case is due to two very different modes of action. The first, or simplest of comprehension, is a simple mechanical process; the descending raindrops or hailstones, by the momentum of their fall and the viscosity or internal friction of the air, drive some air before them, so that beneath the column of falling rain the air is pushed outward in all directions, especially southeastward, in the line of least resistance. The second is a thermodynamic action; the falling rain or hail, no matter whether it is entering warmer air or whether it is driving in front of it air that becomes warm by compression, is in either case being evaporated, and as this evaporation consumes heat (i. e., renders it latent), therefore, the rain, the hail, and the air are each cooled in proportion to the quantity of heat that they give up to the process of evaporation; of course the air in the region at a distance from the falling hail is not cooled. The heavy, cold air thus formed descends with the rain and,